

**California Department of Fish and Game
Permit**

For the

**San Francisco-Oakland Bay Bridge East Span
Seismic Safety Project**

November 2001

Memorandum

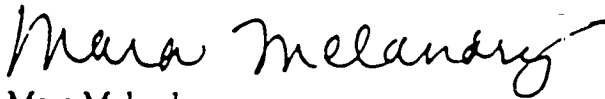
To: Mr. Stephen Puccini
Staff Counsel
Department of Fish and Game
1416 Ninth Street
Sacramento, CA 95814

Date: November 26, 2001
File: 04-SF-80 KP 12.2/14.3
04-ALA-80 KP 0.0/2.1
EA# 04-251-012000

From: DEPARTMENT OF TRANSPORTATION
TOLL BRIDGE PROGRAM

Subject: California Endangered Species Act Incidental Take Permit (No. 2081-2001-021-03)
for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project.

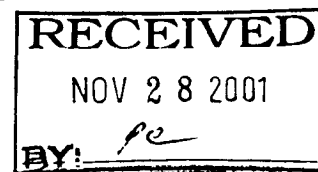
Please find enclosed one original fully executed copy of the subject permit.



Mara Melandry
Environmental Manager, SFOBB

Enclosed

Robert W. Floerke, Regional Manager
Department of Fish and Game – Central Coast Region
✓ Steve Hulsebus, D 4, Toll Bridge Program
Susan Chang, D 4, Toll Bridge Program
Cindy Adams, HQ, Division of Environmental Analysis





California Department of Fish and Game

California Endangered Species Act
Incidental Take Permit No. 2081-2001-021-03
CALIFORNIA DEPARTMENT OF TRANSPORTATION
SAN FRANCISCO-OAKLAND BAY BRIDGE
EAST SPAN SEISMIC SAFETY PROJECT

Authority

The Department of Fish and Game ("Department") is issuing this incidental take permit ("permit") to the California Department of Transportation ("Caltrans" or "the permittee") in conjunction with the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project ("project") pursuant to its authority under the California Endangered Species Acts ("CESA") (Fish & G. Code, § 2050 et seq.). CESA generally prohibits the take¹ of any species that is listed as endangered or threatened, or is a candidate species,² under CESA ("listed species"). However, CESA authorizes the Department to issue a permit that allows a permittee to take a listed species if the take is incidental to an authorize lawful activity and the other conditions specified in section 2081(b) and (c) of the Fish and Game Code are met.

¹"Take" means "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture or kill." (Fish & G. Code, § 86.) As used in this permit, "take" shall have the same meaning as "take" under section 86 of the Fish and Game Code.

²"Candidate species" are species of wildlife that have not yet been placed on the list of endangered or threatened species under CESA, but are under formal consideration by the Fish and Game Commission.

Permittee

California Department of Transportation

Permittee's Contact Person

Mr. Randell Iwasaki, District Director, District 4
California Department of Transportation
c/o Ms. Mara Melandry
Environmental Manager, SFOBB
Box 23660
Oakland, CA 94623-0660

Project Description

The project consists of replacing the existing East Span of the San Francisco-Oakland Bay Bridge ("Bay Bridge") between the City of San Francisco and the East Bay with a new East Span ("East Span"), thereafter removing the existing East Span, and completing all mitigation work required under this permit and by other interested state and federal agencies. Caltrans will construct the new East Span over a five-year period and remove the existing East Span over a two-year period after the new East Span is constructed. The project will therefore take seven years to complete. Caltrans will construct the new East Span under four separate contracts, described as follows: (1) Self-Anchored Suspension/Yerba Buena Island Main Span; (2) Skyway; (3) Oakland Approach Structures; and (4) Geofill at the Oakland Touchdown. Caltrans will remove the existing East Span under a separate demolition contract.

The project will require the use of large-scale equipment and involve labor-intensive activities. Materials and equipment will arrive at the project site by land and water. To provide barge access to construction areas, access channels will be dredged near the Oakland approach structures. The initial dredging on the north side of the existing East Span will generate approximately 216,230 cubic yards ("cy") of material, which will be disposed of at the San Francisco-Deep Ocean Disposal Site ("SF-DODS"). This phase of dredging will be completed over a six month period. Construction of the piers and footings for the new East Span will result in dredging and disposal of 187,087 cy of material. This material will be dredged in smaller amounts over a four year period. This material will be disposed of at the Alcatraz disposal site ("SF-11"), except for the upper twelve feet of material for piers E1 - E6, which will require upland disposal. After the East Span is completed, dismantling of the existing East Span will begin. This will require the dredging of 190,680 cy of material. This material will be beneficially re-used at the Hamilton wetlands restoration site or disposed of at SF-DODS. Demolition of the piers for the existing East Span will result in the dredging of 22,724 cy of material. This

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CALIFORNIA DEPARTMENT OF TRANSPORTATION
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material will be disposed of at SF-11.

To construct the new East Span, Caltrans estimates that 259 large diameter steel piles will need to be driven into San Francisco Bay. Of these, 189 piles will be 8.2 feet in diameter and 70 piles will be 5.9 feet in diameter. These large piles may require a hammer energy level of up to 1,700 kilo Joules ("kJ") (see Attachment 1). Caltrans estimates that 1,300 hours of driving time will be needed to install all the large piles. The length of the piles range from 135 to 358 feet. In order to construct all permanent structures, 1,030 to 2,060 smaller piles will need to be installed to temporary structures, supports, falsework, docks, and construction trestles. These temporary structures will be removed when they are no longer needed. The project also includes all mitigation work required under this permit and by other interested state and federal agencies, including, but not limited to, restoration of salmon habitat in tributaries to central and south San Francisco Bay, on tidal lands along the east shore of San Francisco Bay, on Skaggs Island in Sonoma County, and, potentially, at other locations in San Francisco Bay.

Project Location

The project, including the area around the piers of the new East Span and the area necessary to accommodate construction-related equipment, such as work barges and cranes, is located in San Francisco Bay, between Yerba Buena Island ("YBI") and the City of Oakland. The western limit of the project is the east portal of the YBI tunnel located in the City of San Francisco. The eastern limit of the project is located approximately 1,312 feet (400 meters) west of the Bay Bridge toll plaza on a spit of land referred to as the Oakland Touchdown area in the City of Oakland. The new East Span will be constructed north of the existing East Span and will be approximately 2.18 miles (3.5 kilometers) in length and 230 feet (70 meters) in width, including a 50-foot (15.3-meter) minimum space between the eastbound and westbound bridge decks.

Covered Species

This permit applies to the following species only:

Name	Status ³
1. Sacramento River winter run chinook salmon (<i>Oncorhynchus tshawytscha</i>)	Endangered

³Refers to the status of the species under CESA only.

- | | | |
|----|---|------------|
| 2. | Sacramento River spring run chinook salmon
(<i>Oncorhynchus tshawytscha</i>) | Threatened |
| 3. | Coho salmon north of San Francisco
(<i>Oncorhynchus kisutch</i>) | Candidate |

The above-listed species, and only those species, are hereinafter referred to as "covered species."

Effective Date and Expiration Date of Permit

This permit shall be executed in duplicate original form and shall become effective after a duplicate original is acknowledged by the applicant/permittee (see below) and returned to the Department. Unless renewed by the Department, this permit, which authorizes the incidental take of a covered species, shall expire on October 31, 2009.

Incidental Take Authorization

The Department authorizes the permittee and its employees, contractors, and agents to take a covered species incidental to completing the project, subject to the limitations described in this section and the conditions of approval identified below. This permit does not authorize the intentional take of a covered species; the take of a covered species in the course of activities outside the scope of the project, as described above; the take of a covered species resulting from a violation of the terms and conditions of this permit; or the take of any species listed under CESA or the federal Endangered Species Act ("ESA") that is not a covered species.

Fully Protected Species

This permit does not authorize the take of any fully protected species, including those species listed in sections 3511, 4700, 5050, and 5515 of the Fish and Game Code. The Department has determined that the project could have an adverse effect on the following fully protected species: American peregrine falcon (*Falco peregrinus anatum*); California brown pelican (*Pelecanus occidentalis*); and California least tern (*Sterna albigrons browni*). In an effort to avoid take of these species, the permittee will adhere to the following mitigation measures outlined in the Biological Opinion issued by the U.S. Fish and Wildlife Service ("USFWS") for the project:

1. **California least tern.** A large breeding colony of least terns is present at the Naval Air Station in Alameda ("NAS") south of the project site, and a smaller breeding colony of least terns is present at the Albany mudflats north of the project site. Least terns are known to forage in the shallow

waters of San Francisco Bay, which are similar to the waters at the east end of the project site. If through monitoring it is determined that project construction activities have resulted in the take of one or more least terns, Caltrans shall consult with the Department within twenty-four hours from the time Caltrans discovers or learns of the take to determine the cause of the take and to identify measures to avoid additional take. In addition, Caltrans, after negotiating with the Department and USFWS, will be required to take actions to provide additional predator and vegetation controls at the least tern breeding colony at NAS. Caltrans's restoration of eelgrass beds disturbed by the project will partially address impacts to least tern foraging habitat. Additionally, consistent with the *California Least Tern Recovery Plan* (USFWS, 1977), Caltrans will participate in processes to establish additional California least tern breeding areas at appropriate locations around San Francisco Bay to help stabilize and increase least tern populations.

2. **California brown pelican.** If through monitoring it is determined that the project construction activities have resulted in the take of one or more brown pelicans, Caltrans shall work with the Department and USFWS to evaluate methods to avoid additional project-related impacts to brown pelicans.
3. **American peregrine falcon.** Peregrine falcons, as well as cormorants, which are not fully protected, are known to nest on the existing East Span. Caltrans, in consultation with the Department, shall develop a management plan that addresses potential impacts to peregrine falcons and cormorants. The management plan shall discuss all bridge construction, removal, and maintenance activities and develop schedules for activities in order to avoid the take of peregrine falcons and cormorants, especially during their critical nesting periods.

Conditions of Project Approval

The Department's issuance of this permit and the permittee's authorization to take covered species under this permit, are subject to the permittee's full compliance with, and implementation of, the following conditions of approval:

1. The permittee shall comply with all applicable federal, state, and local laws in effect now, or hereafter enacted, in completing the project.
2. The permittee shall fully implement and adhere to the conditions in the "Bubble Curtain Background and Specifications" attached hereto as

Attachment 1.

3. To ensure that impacts to the covered species are minimized and the mitigation required under this permit is implemented, the permittee shall do all of the following:
- a. Install and maintain an effective air bubble sound attenuation curtain around all large steel piles (i.e., 5.9 - 8.2 feet in diameter) during pile driving activities, unless other equally effective methods (e.g., cofferdams) are used, or as otherwise directed by the Department and the National Marine Fisheries Service ("NMFS") for the purpose of collecting performance data. "Effective" for purposes of this permit shall mean a continuous stream of air bubbles enclosing all permanent in-water piles and/or pile groups from the bottom of San Francisco Bay to its water surface. Airflow to the bubble curtain system shall be sufficient to provide a bubble flux of three cubic meters of air per minute per linear meter of pipeline in each concentric ring.
 - b. To maintain the integrity of the air bubble curtain, no barges, boat traffic, or other structure or equipment may penetrate the bubble curtain during pile driving activities.
 - c. To monitor the performance of the bubble curtain and assess the level of impact to fisheries, Caltrans, in conjunction with the Federal Highways Administration ("FHWA"), shall prepare and implement a fisheries and hydroacoustic monitoring program. The monitoring program shall include the following components: (1) underwater sound measurements at various distances and depths from pile driving operations; (2) observations of predation by gulls and other birds; and (3) experiments using fish in cages at different distances and depths from pile driving operations to evaluate fish mortality and injury rates. The fish cage experiments shall be designed to document near-term fish mortalities and the likelihood of delayed mortality of differing sizes and species of fish that have swim bladders.

Caltrans shall submit the above-described monitoring program to the Department and NMFS for review and approval at least ninety days prior to the initiation of pile driving.

Data collected from the monitoring program shall be made

available to the Department on a real-time basis. An interim report shall be provided to the Department by December 31, 2002, and a final report shall be provided to the Department by June 1, 2004..

- d. To avoid attracting fish with work lights during night-time pile driving operations, pile driving shall be limited to daylight hours to the extent practicable and the use of artificial lights shall be minimized. If needed, illumination for any pile driving operations shall be directed away from the water.
- e. Caltrans shall provide \$4 million for the purpose of monitoring construction-related impacts and restoring the habitat in tributaries to central and south San Francisco Bay of anadromous salmonids listed under CESA and/or ESA, including the covered species ("salmonids" or "salmonid") in accordance with the following conditions:
 - (i) Caltrans shall make available a portion of the \$4 million, not to exceed \$500,000, prior to the initiation of project construction activities, which shall be used to fund the monitoring of fisheries impacts, sound pressure levels, and other environmental conditions associated with pile driving after project construction activities commence.
 - (ii) The remainder of the \$4 million ("restoration funding") shall be used for off-site, out-of-kind mitigation to offset project-related injury and mortality of salmonids.
 - (iii) The restoration funding shall be used solely for salmonid restoration projects in tributaries to central and south San Francisco Bay.
 - (iv) Prior to December 31, 2003, Caltrans shall deposit the restoration funding into an escrow account. Expenditures from the account shall be made at the discretion of the Department and NMFS in consultation with Caltrans and FHWA.
- f. Caltrans shall provide additional mitigation at off-site locations to offset the direct impacts of the project by establishing an escrow account of \$10.5 million to be used as follows: 1) a minimum of \$2.5 million to the East Bay Regional Park District to restore,

enhance, and/or create new aquatic habitat and transitional uplands at the Eastshore State Park and within central San Francisco Bay at the following sites or other suitable locations: Radio Beach Area, Brickyard Cove Area, Albany Beach Area, and Hoffman Marsh; 2) up to \$8 million to acquire approximately 3,200 acres of diked historic baylands at Skaggs Island in Sonoma County, demolish structures and facilities on the site, and take other actions necessary to restore the site to tidal marsh. If any of the \$10.5 million described above has not been fully expended by the time the project is completed, Caltrans shall consult with the Department and other interested state and federal permitting agencies to identify other projects that can be funded with the remaining monies that will offset the project's adverse impacts on fish and wildlife resources.

- g. Caltrans proposes to restore up to 1.73 acres of barge access channel to its pre-construction bathymetry and replant the channel with eelgrass. Stockpiled dredged material and sand will be used to restore the appropriate contours of the channel and the area will be replanted using eelgrass from an adjacent donor site. Caltrans will monitor the replanted eelgrass to evaluate its success. This mitigation proposal is contingent on approval by the Bay Conservation and Development Commission to change its policy governing the use of dredged material for in-bay habitat restoration.
- h. For the duration of construction activities, the permittee shall conduct compliance inspections at least once every week to ensure compliance with all measures specified in this permit to avoid the take of the covered species and to minimize and mitigate project impacts on the covered species and other fish and wildlife resources, especially those associated with pile driving activities ("avoidance, minimization, and mitigation measures" or "measures").
- i. Every month for the duration of construction activities, the permittee shall provide the Department with a written compliance report. The compliance report shall document Caltrans's compliance with, and effectiveness of, all avoidance, minimization, and mitigation measures, including, but not limited to the bubble curtain. After the pile driving is complete, Caltrans shall submit a monitoring report to the Department on a quarterly basis.

Beginning in 2002 and continuing for the duration of the project, the permittee shall provide the Department a status report by July 1 of every year. Each status report shall include, at a minimum, the following information: 1) a general description of the project's status, including actual or projected completion dates, if known; 2) the current status of each avoidance, minimization, and mitigation measure; and 3) an assessment of the effectiveness of each completed or partially completed avoidance, minimization, and mitigation measure.

- k. No later than 45 days after completion of the project, including completion of all avoidance, minimization, and mitigation measures, the permittee shall provide the Department with a final mitigation report. The final mitigation report shall be prepared by a knowledgeable, experienced biologist and shall include, at a minimum, the following information: 1) a report showing when each of the measures was implemented; 2) all available information about project-related incidental take of covered species; 3) information about other project impacts on covered and non-covered species; 4) project construction dates; 5) an assessment of the effectiveness of the avoidance, minimization, and mitigation measures included in this permit on the covered species, especially the bubble curtain; and 6) recommendations on how such measures might be changed to more effectively avoid, minimize, and mitigate the impacts of similar future projects on the covered and non-covered species.

The permittee shall provide Department representatives access to the project site and mitigation areas under its control, and shall otherwise fully cooperate with Department efforts to verify Caltrans's compliance with, or the effectiveness of, all avoidance, minimization, and mitigation measures.

- m. Notwithstanding this permit's expiration date, the permittee's obligations under this permit shall not end until the Department accepts the permittee's final mitigation report as satisfactory and complete.
4. This permit may be amended without the concurrence of the permittee if the Department determines that continuing the project the existing conditions of this permit could jeopardize the continued existence of a covered species or a CESA-listed non-covered species or there is a

change in biological conditions that necessitates amending the permit to ensure that impacts to the covered species are minimized and fully mitigated.

5. The Department may issue the permittee a written stop work order to suspend any activity covered by this permit for an initial period of up to 25 days to prevent a violation of this permit or the illegal take of a listed species. The permittee shall comply with the stop work order immediately upon its receipt. The Department may extend a stop work order for a period not to exceed 25 additional days upon written notice to the permittee. The Department shall commence the process to formally suspend this permit pursuant to section 783.7 of title 14 of the California Code of Regulations within five working days of issuing a stop work order or an extended stop work order.

Compliance With Other Laws

This permit authorizes the incidental take only of the covered species after Caltrans begins the project. This permit does not by itself entitle Caltrans to proceed with the project. Caltrans is responsible for complying with all other applicable federal, state, and local laws in order to proceed with the project.

Notices

All written notices, reports, and other communications that are required under, or relate to, this permit shall be delivered to the Department by first class mail at the following addresses, unless the Department instructs Caltrans otherwise:

Original to: Mr. Robert W. Floerke
Regional Manager, Region 3
P.O. Box 47
Yountville, CA 94599

Copy to: Office of the General Counsel
Department of Fish and Game
1416 Ninth Street, 12th Floor
Sacramento, CA 95814

CESA Findings

With respect to CESA and the issuance of this permit, the Department finds that based on the administrative record, all of the following conditions have been met:

1. The take of any covered species will be incidental to an otherwise lawful activity (i.e., Caltrans's completion of the project).
2. Where various measures are available to meet the minimization and mitigation requirements under CESA, the measures required will maintain Caltrans's project objectives to the greatest extent possible.
3. All required minimization and mitigation measures can be successfully implemented.
4. This permit is consistent with regulations adopted pursuant to sections 2112 and 2114 of the Fish and Game Code.
5. Caltrans has ensured that there will be adequate funding to implement the minimization and mitigation measures required by this permit, and to monitor its compliance with, and the effectiveness of, those measures.
6. Based on the best scientific and other information reasonably available, the Department has determined that the issuance of this permit will not jeopardize the continued existence of the covered species. Further, this permit takes into account the capability of the covered species to survive and reproduce and any adverse impacts the project could have on those capabilities in light of the following: a) known population trends; b) known threats to the covered species; and c) reasonably foreseeable impacts on the covered species from other related projects and activities. This finding is based, in part, on the Department's express authority to amend this permit as necessary to avoid jeopardizing the continued existence of the covered species.

Attachments

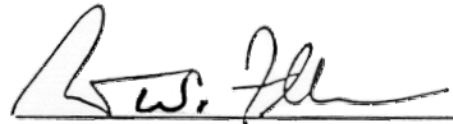
The following attachments are made part of this permit by reference:

Attachment 1: "Bubble Curtain Background and Specifications"

Attachment 2: "Department of Fish and Game Monitoring and Reporting Program"

THIS PERMIT IS ISSUED BY THE CALIFORNIA DEPARTMENT OF FISH AND GAME
ON Nov. 19, 2001.

By:



Robert Floerke, Regional Manager
Central Coast Region

Approved as to legal form:



Michael R. Valentine, General Counsel

ACKNOWLEDGMENT

The undersigned as a duly authorized representative of the permittee acknowledges receipt of this permit and, by signing the permit, accepts and agrees to comply with all of its terms and conditions.

By: 

Date: 11/21/01

Name: H.P. HONSLY

Title: CHIEF DEPUTY

Attachment 1

Bubble Curtain Background and Specifications

The underwater sound pressure waves that have the potential to affect salmonids originate with the contact of the hammer with the top of the steel pile. The impact of the hammer on the top of the pile causes a wave to travel down the pile and causes the pile to resonate radially and longitudinally like a gigantic bell. Most of the acoustic energy is a result of the outward expansion and inward contraction of the walls of the steel pipe pile as the compression wave moves down the pile from the hammer to the end of the pile buried in the bay bottom. Water is virtually incompressible and the outward movement of the pipe pile wall by a fraction of an inch sends an underwater pressure wave propagating outward from the pile in all directions. The molecular elasticity of the steel pipe pulls the pile walls back inward with the water following the inward movement of the pipe wall, resulting in the propagation of an under-pressure wave. The steel pipe pile resonates sending out a succession of waves even as it is pushed several inches deeper into the bay bottom.

There is very little literature on the effects of underwater shock waves generated by pile driving on aquatic life. There are a few referenced publications, but most of the information is contained in "gray literature" publications produced for government agencies that are project specific. The monitoring methods have not been standardized and measurements tend to be sporadic (Keevin *et al.*, 1999).

Structural damage to the fish inner ear by intense sound has been examined by Enger (1981) and Hastings *et al.* (1995, 1996) with scanning electron microscopy. Hastings *et al.* (1996) found destruction of sensory cells in the inner ears of oscar (*Astronotus ocellatus*) four days after being exposed to continuous sound for one hour at 180 dB re:1 iPa and 300 Hz. Hastings (1995) also reported that 13 out of 34 goldfish exposed for two hours to sound pressure levels ranging from 192 to 204 dB re:1 iPa at either 250 or 500 Hz experienced equilibrium problems that included swimming backwards and/or upside down and wobbling from side to side. These fish recovered within one day suggesting that the damage was not permanent. This fish behavior could have been caused by post-traumatic vertigo (i.e., lack of balance and dizziness caused by a problem in the inner ear) similar to that experienced by humans after a severe blow to the body or head.

Fish can also die when exposed to lower sound pressure levels if exposed for longer periods of time. Hastings (1995) found death rates of 50 percent and 56 percent for gouramis (*Trichogaster sp.*) when exposed to continuous sounds at 192 dB re:1 iPa at 400 Hz and 198 dB re:1 iPa at 150 Hz, respectively, and of 25 percent for goldfish (*Carassius auratus*) when exposed to sounds of 204 dB re:1 iPa at 250 Hz for two hours or less. Hastings (1995) also reported that acoustic

“stunning,” a potentially lethal effect resulting in a physiological shutdown of body functions, immobilized gourami within eight to thirty minutes of exposure to the aforementioned sounds.

Loud sounds can have detrimental effects on fish by causing stress, increasing risk of mortality by reducing predator avoidance capability, and interfering with communication necessary for navigation and reproduction. Scholik and Yan (2001) reported temporary threshold shifts for fathead minnows (*Pimephales promelas*) exposed to 24 hours of white noise with a bandwidth of 300 - 4000 Hz and overall sound pressure level of only 142 dB re:1 μ Pa. Their results indicated that the effects could last longer than 14 days. Even if threshold shifts do not occur, loud sounds can mask the ability of aquatic animals to hear their environment. Based on the sound pressures and exposure times for sensory hair cell damage reported by Hastings (1995) and Hastings *et al.* (1996), and an assumption of deposition of equivalent acoustic energy in the inner ear over time, fish could experience damage to the inner ear if they remained in the direct vicinity (at 200-210 dB re:1 μ Pa peak sound pressure) of the pile driving activity for more than a few minutes. Thus, even with an air bubble curtain in place, some fish with swim bladders will most likely be affected in this manner during construction of the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project (“project”).

Pile driving may result in “agitation” of salmonids indicated by a change in swimming behavior (Shin, 1995). Salmon and steelhead may exhibit a startle response to the first few strikes of a pile. The startle response is a quick burst of swimming that may be involved in avoidance of predators (Popper, 1997). A fish that exhibits a startle response is not in any way injured, but it is exhibiting behavior that suggests it perceives a stimulus indicating potential danger in its immediate environment. Fish do not exhibit a startle response every time they experience a strong hydro-acoustic stimulus. The startle response is likely to extinguish after a few pile strikes.

The following examples of pile driving projects provide some additional insight to the potential effects of the project on listed salmonids:

At the Hong Kong Airport Fuel Transfer Facility project an air bubble ring with a diameter of 50 meters (“m”) was placed around the pile-driving operation. The pile driver was a six metric ton diesel hammer at 90 kilojoules (“kJ”). Hammer strikes resulted in underwater pulses of sound about 40 milliseconds in duration. The effective source level (inferred by extrapolating from the longer-distance measurements) was 238 dB re: 1 μ Pa at one meter without bubbles and 234 dB with bubbles. On average, the bubble screen diminished the sound pressures by 4 dB. The contractor did not measure peak pressures. It was also observed that low and high frequency sounds were not attenuated by the air bubble curtain. The peak pressure of sound anticipated to occur during the proposed project

(268 dB re: 1 μ Pa at one meter) far exceeds the level observed for the Hong Kong project.

At the Canada Place Cruise Ship Terminal in Vancouver, B.C., open-ended steel pipe piles 36 inches in diameter with 0.75-inch wall thickness were driven, as were 24-inch diameter closed-ended steel pipe piles with 0.75-inch wall thickness (Longmuir and Lively, 2001). An air bubble curtain was developed to protect fish. It was kept as close to the pile as practical, allowing for battered (slanted) piles to be driven. The authors stated that a proper bubble curtain can reduce underwater sound overpressures from pile driving by at least 85 percent (16.5 dB) and that their bubble curtain in Vancouver reduced underwater overpressures during pile driving from more than 22 psi to less than 3 psi (a reduction of more than 17 dB). They referred to the Canada Department of Fisheries and Oceans's criterion for fish safety of not exceeding an explosion blast peak pressure of 14.5 psi (220 dB re: 1 μ Pa). The Vancouver study found that, perhaps due to the repetitive nature of pile driving, the peak pressure should be less than 4.5 psi (210 dB re: 1 μ Pa) to protect small fish. This is documented by Rasmussen (1967), who found that 3-6 month old salmon were killed at levels exceeding 2.7 psi (204 dB re: 1 μ Pa).

To assess the environmental and technical factors involved in driving very large piles proposed for the project, a Pile Installation Demonstration Project ("PIDP") was undertaken in late 2000 in which three eight-foot diameter steel pipe pilings were driven into the San Francisco Bay (Illingworth and Rodkin, 2001). The underwater sound measurements were not comprehensive, but important data came from two measurements at hydrophone depth of 6 m, without a sound attenuation system in place. Using a pile-driver energy of 900 kJ, peak pressure of 207 dB re: 1 μ Pa at a distance of 103 m and 191 dB at distance of 358 m were measured. Applying the spreading-loss model for received levels, the corresponding equation is:

$$RL \text{ (dB re: 1 } \mu\text{Pa)} = 266.5 - 29.6 \cdot \log(R) \text{ for } R \text{ in m.}$$

The attenuation loss rate was almost 30 dB per tenfold change in distance, close to the 28 dB per tenfold change in distance observed at the Hong Kong refueling facility discussed above.

The maximum pile-driver energy available for the proposed project is 1700 kJ. Applying the scaling suggested above, the peak pressure would be expected to have been $20 \cdot \log(1700/900)0.33 = 1.8$ dB more at the higher energy level, or almost 209 dB at distance of 103 m. Thus, when the energy is 1700 kJ, the constant term will be 268.5 dB in the equation for received level.

At the Baldwin Bridge piers in Connecticut, underwater acoustic measurements from the demolition pounding of a "hoe ram" were recorded by Dolat (1997). The

ram struck the pier approximately four times per second creating loud pulsed sine waves with each blow. Four strikes per second was equivalent to a continuous 170 dB re: 1 μ Pa. Based on these estimates of the peak sound pressure levels, the report concluded that fish less than 30 m away could experience permanent auditory system damage, temporary and possibly permanent loss of equilibrium or complete incapacitation. The report included a brief discussion of previously unreported studies that show that beyond a brief startle response associated with the first few acoustic exposures, fish do not move away from areas of very loud noises and can be expected to remain in the area unless they are carried away by the river currents.

In Puget Sound, pile driving operations have been reported to disrupt juvenile salmon behavior (Feist *et al.*, 1992). Although no underwater sound measurements are available from that study, comparisons between juvenile salmon schooling behavior in areas subjected to pile driving/construction and other areas where there was no pile driving/construction indicate that there were fewer schools of fish in the pile-driving areas than in the non-pile driving areas. The results are not conclusive but there is a suggestion that pile-driving operations may result in a disruption in the normal migratory behavior of the salmon in that study, although the mechanisms salmon may use for avoiding the area are not understood at this time.

Based on the effectiveness of the air bubble curtain used during the Canada Place project and results from the PIDP, Greene (2001) estimates that fish beyond 44 m from the pile driving operation in the project will generally survive, assuming a 10 dB reduction in sound pressure levels from the bubble curtain. However, Greene (2001) assumes that immediate mortality of fish is limited to levels of 210 dB and greater. Rassmusen (1967) suggests immediate mortality of juvenile salmonids may occur at sound pressure levels exceeding 204 dB. In consideration of this uncertainty, the National Marine Fisheries Service ("NMFS") estimates fish beyond 69 m (204 dB re: 1 μ Pa) will generally survive during the large hammer pile driving with an air bubble curtain in the project, assuming a 10 dB reduction in sound pressure levels. Outside the radius of 69 m, up to possibly 440 m (180 dB re: 1 μ Pa), fish are likely to be injured and result in some level of delayed mortality. Still further out from the pile driving activity, up to possibly 4,400 m (150 dB re: 1 μ Pa), fish may exhibit temporary abnormal behavior indicative of stress or exhibit a startle response, but not sustain substantial harm or injury.

Listed salmonids exposed to high sound pressure levels within 69 m of the pile during the operation of large hammers at the East Span Project could be subject to immediate mortality from barotrauma. Barotrauma is pathologies associated with exposure to drastic changes in pressure. These include hemorrhage and rupture of internal organs, including the swim bladder and kidneys in fish. Death can be instantaneous, occur within minutes after exposure, or occur several days

later. Bubble expansion in blood vessels can cause hemorrhaging

Gisiner (1998) reports swim bladders of fish can perforate and hemorrhage when exposed to blast and high-energy impulse noise underwater. Inside the 69 m radius of an active pile driving operation, a very strong shock wave or high pressure/low pressure cycle may result in a rupture of the swim bladder. If the swim bladder bursts and the air escapes from the body cavity or is forced out of the pneumatic duct, the fish may sink to the bottom. If the swim bladder bursts but the air stays inside the body cavity, the fish is likely to stay afloat but have some difficulty in maneuvering or maintaining orientation in the water column. Barotrauma, including rupture of the swim bladder of several species of fish, was observed during the PIDP.

Immediately beyond the 69 m radius from a pile driving event, fish are expected to experience trauma in many organs including the inner ear, eyes, blood, nervous system, kidney, and liver. As the underwater sound pressure wave generated by a pile strike passes through a fish, the swim bladder will be rapidly squeezed due to the high pressure and then rapidly expand as the underpressure component of the wave passes through the fish. At relatively low sound pressure levels, only a fraction of 1 psi above the ambient sound pressure level in the environment, the swim bladder will rhythmically expand and contract with no adverse effect. The swim bladder routinely expands and contracts as salmonids swim near the surface or swim in deeper water near the bottom. At high sound pressure levels of pile driving, the swim bladder may repeatedly expand and contract, hammering the internal organs that cannot move away since they are bound by the vertebral column above and the abdominal muscles and skin that hold the internal organs in place below the swim bladder (Gaspin, 1975). This pneumatic pounding may result in the rupture of capillaries in the internal organs as indicated by observed blood in the abdominal cavity, and maceration of the kidney tissues. The pneumatic duct, which connects the swim bladder with the esophagus, may not make a significant difference in the vulnerability of the salmonids since it is so small relative to the volume of the swim bladder (Gaspin, 1975).

The effects discussed above will be directly dependant on the resulting sound pressure levels experienced by an individual fish during pile driving at the project. The sound pressure levels and the degree of effect depends on many factors including:

- 1 size and force of the hammer strike;
- 2 distance from the pile;
- 3 depth of the water around the pile

4. depth of the fish in the water column;
 5. amount of air in the water;
 6. texture of the surface of the water (size and number of waves on the water surface);
 7. bottom substrate composition and texture;
 8. size of the fish;
 9. species of fish;
- presence of a swim bladder;
- physical condition of the fish; and
- effectiveness of bubble curtain sound/pressure attenuation technology.

Water depths in the project area are relatively shallow, less than 5 m, for approximately two-thirds of the large piles. In shallow water, much of the acoustic energy can be absorbed by the bottom and reflected off the surface back down to the bottom and even backwards towards the pile. Thus, the rate of attenuation is much higher in shallower water and the expected area of adverse effects is expected to be reduced.

The project is located in an area of strong tidal currents, and tidal currents are expected to influence the level of adverse affect to listed species. Adult and juvenile salmonids are likely to take advantage of tidal currents to travel through San Francisco Bay on their migration routes. The large volume of tidal exchange at the project construction site is expected to assist with the transport of listed salmonids both to and away from areas of high sound pressure levels during pile driving.

Tidal currents will also influence the performance of the bubble curtain sound attenuation system. Bubble curtains work best in areas not influenced by currents, because moving water will carry the upward-traveling air bubbles away from the pile. If the pile is not completely encapsulated by air bubbles, high sound pressure waves are likely to travel into San Francisco Bay through areas thin or devoid of air bubbles.

Depending on the effectiveness of the sound attenuation system proposed for the project, it is reasonable to assume a potentially large area of impact from sound generated from pile driving. However, there are both temporal and spatial parameters to consider as well. Spatial parameters include known migratory

pathways within the action area and San Francisco Bay for the various listed ESUs. For the three listed ESUs originating from the Central Valley (Central Valley steelhead, Central Valley spring-run chinook salmon, Sacramento River winter-run chinook salmon), it is believed that adult fish generally remain on the north side after entering the bay through the Golden Gate, migrating rapidly around Angel Island and through San Pablo Bay towards the Delta and their natal Central Valley streams. Although adult salmon have been recorded feeding near YBI in the summer, these numbers are probably small. For juvenile salmonid smolts originating from Central Valley streams, it is generally thought that they, too, utilize the north side of the Bay as their primary migration corridor. It is also the consensus of California salmon researchers that juvenile salmonids migrate relatively quickly through San Francisco Bay en route to productive feeding areas off the Pacific coast.

Central California Coast coho salmon utilize two streams in Marin County (one empties into Richardson Bay, the other into north San Francisco Bay) and neither adults nor juveniles (emigrating as one year-olds) are expected to be near the pile driving area during their migration between the ocean and natal streams.

Cofferdams may be used by the contractors to dewater some pile installation sites. If cofferdams are installed, sediment will be excavated and the cofferdam dewatered. The steel pipe piles would be driven after dewatering into the Alameda geologic formation. It is anticipated that the layer of air and the coffer dam itself surrounding the pile will effectively attenuate sound pressure waves to safe levels for aquatic organisms in the Bay including listed salmonids. Cofferdams are likely to be used in shallowest areas at the Oakland Touchdown which will avoid adverse effects during the driving of these piles.

To attenuate the effects of sound pressure waves on fish, a bubble curtain system will be required for driving of all permanent in-water piles. A continuous stream of air bubbles will enclose all permanent in-water piles/pile groups during the pile driving process, unless other equally effective methods such as cofferdams are used, or as otherwise directed by Caltrans, in consultation with the Department and NMFS, for the purpose of collecting performance data. Contractor specifications will stipulate the positioning, configuration, operation and removal of the bubble curtain system. The bubble curtain system will consist of air compressors, air supply lines, distribution manifolds, and aeration pipelines.

The aeration pipe will be perforated pipe configured into concentric rings spaced no more than five vertical meters apart at all tide conditions. The lowest aeration pipeline layer will be designed to ensure contact with the mud line without sinking into bay mud. The bubble curtain system will be constructed on a frame designed to keep the aeration pipelines stable (horizontal) and to provide enough ballast to counteract any inherent buoyancy of the system during operation. When emplaced, the bubble curtain system must be configured such that the

aeration pipelines completely enclose the pile/pile group at a minimum distance of two meters. Each aeration pipeline will have four adjacent rows of approximately 1.6 mm diameter air holes spaced approximately 20 mm apart. The bubble curtain system will provide a bubble flux of three cubic meters per minute, per linear meter (32 cubic feet per minute, per linear foot) of pipeline in each concentric ring. Valves and gauges to measure air pressure and flow rates will be installed in the main air supply lines and at critical branch locations and shall be accurate to +/- 2 percent. All gauges shall be installed to be accessible to Caltrans inspectors. The contractor will keep a log and graphic plot of all gauge readings, with data logged during every 30 minutes of operation. If the reading of any gauge drops below 10 percent of normal operation, pile driving will stop until the defect is repaired to the satisfaction of Caltrans's Engineer.

The contractor must submit a bubble curtain system design and supporting calculations for Caltrans's review within two months of receiving notice to proceed on the project. Caltrans will comment on the system within one month and the contractor shall respond within two weeks of Caltrans's comments. The contractor will be required to demonstrate the operation of the bubble curtain system during the re-strike of the PIDP piles. The contractor will ensure that bubble "drift" at maximum tidal flux or current does not compromise the integrity of the continuous bubble curtain. The pile-driving barge will also be isolated so that noise from the pile installation is not transmitted through the barge into the water-column.

Attachment 2

DEPARTMENT OF FISH AND GAME MITIGATION MONITORING AND REPORTING PROGRAM

CALIFORNIA INCIDENTAL TAKE PERMIT NO. 2081-2001-021-03

PERMITTEE: California Department of Transportation

PROJECT: California Department of Transportation San Francisco-Oakland Bay Bridge East Span Seismic Safety Project

PURPOSE OF THE MMRP

The purpose of the Mitigation Monitoring and Reporting Program ("MMRP") is to ensure that the measures required by the Department of Fish and Game ("Department") to minimize and mitigate impacts on the covered species associated with the above-referenced project are properly implemented, thereby ensuring compliance with section 2081(b) of the Fish and Game Code.

OBLIGATIONS OF PERMITTEE

The minimization and mitigation measures listed in the table shall be implemented within the time periods indicated. The permittee shall be solely responsible for monitoring compliance with all minimization and mitigation measures and for reporting to the Department on its progress in implementing those measures in accordance with the permit and MMRP.

VERIFICATION OF COMPLIANCE AND EFFECTIVENESS

The Department may verify, at its sole discretion, the permittee's compliance with any minimization or mitigation measures and/or independently assess the effectiveness of those measures.

TABLE OF MINIMIZATION AND MITIGATION MEASURES

The below "Table of Minimization and Mitigation Measures," which is part of the MMRP, summarizes some of the minimization and mitigation measures required by the Department under the above-referenced incidental take permit ("permit"). The table serves only as a tool to be used by Caltrans and the Department to monitor and report on the minimization and mitigation measures required under the permit. The table does not include every minimization and mitigation measure required under the permit, or necessarily fully describe those measures that are listed in the table. Such omissions or discrepancies shall not be construed as relieving the permittee of complying with

those minimization and mitigation measures required under the permit that are not included or fully described in the table. The permittee shall comply with every avoidance, minimization, and mitigation measure required under the permit.

The following items are included in the table for each minimization and mitigation measure: "Mitigation Measure"; "Source"; "Implementation Schedule"; "Responsible Party"; and "Status/Date/Initials." The "Mitigation Measure" column summarizes the specified minimization or mitigation requirement under the permit. The "Source" column identifies the document that requires the minimization or mitigation measure, which, in this case, is the permit. The "Implementation Schedule" column lists the date or project phase by which the responsible party must implement the minimization or mitigation measure. The "Responsible Party" column identifies the party responsible for implementing the minimization or mitigation measure. The "Status/Date/Initials" column must be completed by the permittee during the preparation of each status report and the final mitigation report, and must identify the implementation status of each minimization and mitigation measure; the date the permittee determined the status; and the initials of the individual determining the status.

TABLE OF MINIMIZATION AND MITIGATION MEASURES

	Mitigation Measure	Source	Implementation Schedule	Responsible Party	Status / Date / Initials
1	Permittee shall fully implement and adhere to the conditions in the "Bubble Curtain Background and Specification" (Attachment 1).	Permittee	During construction	Permittee	
2	Install and maintain an effective air bubble sound attenuation curtain around all large steel piles (i.e., 5.9 - 8.2 feet in diameter) during pile driving activities, unless other equally effective methods (e.g., cofferdams) are used, or as otherwise directed by the Department and the National Marine Fisheries Service ("NMFS") for the purpose of collecting performance data. "Effective" for purposes of this permit shall mean a continuous stream of air bubbles enclosing all permanent in-water piles and/or pile groups from the bottom of San Francisco Bay to its water surface. Airflow to the bubble curtain system shall be sufficient to provide a bubble flux of three cubic meters of air per minute per linear meter of pipeline in each concentric ring.	Permit	During construction	Permittee	
3	To monitor the performance of the bubble curtain and assess the level of impact to fisheries, Caltrans, in conjunction with the Federal Highways Administration ("FHWA"), shall prepare and implement a fisheries and hydroacoustic monitoring program. The monitoring program shall include the following components: (1) underwater sound measurements at various distances and depths from pile driving operations; (2) observations of predation by gulls and other birds; and (3) experiments using fish in cages at different distances and depths from pile driving operations to evaluate fish mortality and injury rates. The fish cage experiments shall be designed to document near-term fish mortalities and the likelihood of delayed mortality of differing sizes and species of fish that have swim bladders. Caltrans shall submit the above-described monitoring program to the Department and NMFS for review and approval at least ninety days prior to the initiation of pile driving. Data collected from the monitoring program shall be made available to the Department on a real-time basis. An interim report shall be provided to the Department by December 31, 2002, and a final report shall be provided to the Department by June 1, 2004.	Permit	During construction Interim report due by December 31, 2002 Final report due by June 1, 2004	Permittee	
4	Pile driving shall be restricted to daylight hours to the extent practicable and the use of artificial lights shall be minimized.	Permit	During pile driving	Permittee	

	Mitigation Measure	Source	Implementation Schedule	Responsible Party	Status / Date / Initials
5	Caltrans shall provide \$4 million for the purpose of monitoring construction-related impacts and restoring the habitat in tributaries to central and south San Francisco Bay of anadromous salmonids listed under CESA and/or ESA, including the covered species ("salmonids"). Caltrans shall make available a portion of the \$4 million, not to exceed \$500,000, prior to the initiation of project construction activities, which shall be used to fund the monitoring of fisheries impacts, sound pressure levels, and other environmental conditions associated with pile driving after project construction activities commence.	Permit	Prior to initiation of project construction activities	Permittee	
6	The remainder of the \$4 million ("restoration funding") shall be used for off-site, out-of-kind mitigation to offset project-related injury and mortality of salmonids.	Permit	December 31, 2004	Permittee	
7	Prior to December 31, 2003, Caltrans shall deposit the restoration funding into an escrow account. Expenditures from the account shall be made at the discretion of the Department and NMFS in consultation with Caltrans and FHWA.	Permit	December 31, 2003	Permittee	
8	Caltrans shall provide additional mitigation at off-site locations to offset the direct impacts of the project by establishing an escrow account of \$10.5 million to be used as follows: 1) a minimum of \$2.5 million to the East Bay Regional Park District ("EBRPD") to restore, enhance, and/or create new aquatic habitat and transitional uplands at the Eastshore State Park and within central San Francisco Bay at the following sites or other suitable locations: Radio Beach Area, Brickyard Cove Area, Albany Beach Area, and Hoffman Marsh; 2) up to \$8 million to acquire approximately 3,200 acres of diked historic baylands at Skaggs Island in Sonoma County, demolish structures and facilities on the site, and take other actions necessary to restore the site to tidal marsh. If any of the \$10.5 million described above has not been fully expended by the time the project is completed, Caltrans shall consult with the Department and other interested state and federal permitting agencies to identify other projects that can be funded with the remaining monies that will offset the project's adverse impacts on fish and wildlife resources.	Permit	February 28, 2002	Permittee	
9	Caltrans proposes to restore up to 1.73 acres of barge access channel to its pre-construction bathymetry and replant the channel with eelgrass. Stockpiled dredged material and sand will be used to restore the appropriate contours of the channel and the area will be replanted using eelgrass from an adjacent donor site. Caltrans will monitor the replanted eelgrass to evaluate its success. This mitigation proposal is contingent on approval by the Bay Conservation and Development Commission to change its policy governing the use of dredged material for in-bay habitat restoration.	Permit	Post-construction	Permittee	
10	For the duration of construction activities, the permittee shall conduct compliance inspections at least once every week to ensure compliance with all measures specified in this permit to avoid the take of the covered species and to minimize and mitigate project impacts on the covered species and other fish and wildlife resources, especially those associated with pile driving activities ("avoidance, minimization, and mitigation measures" or "measures").	Permit	Weekly	Permittee	

	Mitigation Measure	Source	Implementation Schedule	Responsible Party	Status / Date / Initials
11	Every month for the duration of construction activities, the permittee shall provide the Department with a written compliance report. The compliance report shall document Caltrans's compliance with, and effectiveness of, all avoidance, minimization, and mitigation measures, including, but not limited to the bubble curtain. After the pile driving is complete, Caltrans shall submit a monitoring report to the Department on a quarterly basis.	Permit	Monthly during pile driving, quarterly thereafter	Permittee	
12	Beginning in 2002 and continuing for the duration of the project, the permittee shall provide the Department a status report by July 1 of every year. Each status report shall include, at a minimum, the following information: 1) a general description of the project's status, including actual or projected completion dates, if known; 2) the current status of each avoidance, minimization, and mitigation measure; and 3) an assessment of the effectiveness of each completed or partially completed avoidance, minimization, and mitigation measure.	Permit	Annually	Permittee	
13	No later than 45 days after completion of the project, including completion of all avoidance, minimization, and mitigation measures, the permittee shall provide the Department with a final mitigation report. The final mitigation report shall be prepared by a knowledgeable, experienced biologist and shall include, at a minimum, the following information: 1) a report showing when each of the measures was implemented; 2) all available information about project-related incidental take of covered species; 3) information about other project impacts on covered and non-covered species; 4) project construction dates; 5) an assessment of the effectiveness of the avoidance, minimization, and mitigation measures included in this permit on the covered species, especially the bubble curtain; and 6) recommendations on how such measures might be changed to more effectively avoid, minimize, and mitigate the impacts of similar future projects on the covered and non-covered species.	Permit	At project completion	Permittee	